Attorney Docket No.: 42390P12328

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

In re application of:)
)
Nehru et al.)
)
Application No: 10/043,764)
)
Filed: January 8, 2002)
)
For: ENHANCED MULTIWAY RADIX)
TREE AND RELATED METHODS)

Examiner: Yicun Wu

Art Unit: 2175

Assistant Commissioner For Patents
P.O. Box 1450
Alexandria, VA 22313-1450

APPEAL BRIEF
IN SUPPORT OF APPELLANTS' APPEAL TO THE BOARD OF PATENT APPEALS AND INTERFERENCES

Applicants (hereafter "Appellants") hereby submit this Brief in support of an Appeal from a Final Office Action, mailed April 7, 2005, in the above-referenced patent application. Appellants respectfully request consideration of this Appeal by the Board of Patent Appeals and Interferences for allowance of the above-referenced patent application.

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I. REAL PARTY IN INTEREST

The real party in interest of the above-referenced U.S. Patent application is Intel Corporation of 2200 Mission College Boulevard, Santa Clara, California 95052, to whom the application has been assigned.

II. RELATED PROCEEDINGS

To the best of Appellants' knowledge, there are no prior or pending appeals, interferences, or judicial proceedings related to the subject matter of this appeal that will directly affect, be directly affected by, or have a bearing on the Board's decision in the pending appeal.

III. STATUS OF THE CLAIMS

Claims 10-11 and 15-17 have been withdrawn.

Claims 1-9 and 12-14 are pending in the above-referenced application. In the Final Office Action mailed April 7, 2005, claim 9 was objected to as being dependent upon rejected base claims, and claims 1-8 and 12-14 were finally rejected. These claims are the subject of this Appeal.

IV. STATUS OF AMENDMENTS

In response to the Final Office Action mailed April 7, 2005 rejecting the claims as set forth in Section III, Appellants filed a Notice of Appeal on July 7, 2005. No amendments have been filed in response to the Final Office Action mailed April 7, 2005. A claim listing showing the status of the claims is attached hereto as Appendix A.

V. SUMMARY OF THE INVENTION

A search tree is created where physical nodes are assigned logical level numbers. The keys are strings of symbols. The symbols can be assigned a logical level number, which may or may not be the same as the physical node level. Keys may be stored in the nodes based on the logical level numbers. Pointers may indicate a next level of nodes wherein keys are stored. Rather than having a node point to the next physical node, a node may point to the next logical level. See, inter alia, Specification, page 8, line 6 to page 10, line 15.

VI. GROUNDS OF REJECTION

Claims 5-9 and 12-14 stand objected to as follows: "the Examiner is not clear about the meaning of the claim. '...corresponding.' (sic) Does corresponding [means] the root node and the node in the first-level have similar value? Or, [Does] corresponding [means] the root node and the node in the first-level have equal value? What is the definition of corresponding?"

Claims 1-8 and 12-14 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 6,396,841 of Rochberger (*hereafter "Rochberger"*) in view of U.S. Patent No. 5,095,458 of Lynch et al. (*hereafter "Lynch"*).

Claim 9 stands objected to as being dependent upon a rejected base claim.

VII. ARGUMENT

CLAIM OBJECTIONS

Based on the Term "Corresponding"

Claims 5-9 and 12-14 were objected to for reason that the term "corresponding" was considered to be unclear. Appellants are unable to understand what is causing confusion regarding the term "corresponding." A definition of the term can be found at www.dictionary.com, which defines the term as meaning being "in agreement, harmony, or conformity," or being "similar or equivalent in character, quantity, origin, structure, or function." Appellants note that when followed by the word "to," resulting in the expression "corresponding to...," the expression refers to agreement or similarity with the object of the preposition "to." Claims 5 and 12 are reproduced below, with the term "corresponding" highlighted in bold, the prepositional phrase "to" underlined, and the object of the preposition highlighted in bold:

From claim 5:

> creating a root node and first-level nodes of a tree for storing keys in a memory, each key having a string of symbols;
>
> creating a pointer from the root node to a node in the first-level of nodes **corresponding** to the **first symbol** in a key;
>
> creating a second level of nodes to store an entry for the key in a node **corresponding** to the **last symbol** in the key; and
>
> creating a pointer from the node in the first-level of nodes **corresponding** to the **first symbol** in the key to the node in the second level of nodes **corresponding** to the **last symbol** in the key.

From claim 12:

> a register to store an entry for a key having a string of symbols in a tree data structure representing a table; and
>
> a node generator to add a node to the tree to store the key entry based on the last symbol of the key, wherein the node is assigned a logical level number **corresponding** to the **length** of the key; and
>
> wherein the logical level number of the node storing the key is used to find the key instead of a path between nodes **corresponding** to **each symbol** in the key.

Thus, Appellants are unable to understand the confusion over the term "corresponding." Appellants respectfully submit that the use of the term is clear throughout the claims, clearly setting forth the element of comparison in each instance of the use of corresponding in each of the claims. Therefore, Appellants respectfully submit that the objection to these claims is improper and petition the Board to overrule this objection.

Based on Dependency on a Rejected Base Claim

Claim 9 was objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form. Appellants respectfully submit that this claim is allowable over the cited references for at least the reasons set forth herein for claim 5, upon which claim 9 depends. Therefore, Appellants respectfully submit that the objection to this claim is improper and petition the Board to overrule this objection.

CLAIM REJECTIONS

Claims 1-8 and 12-14 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 6,396,841 of Rochberger (*hereafter "Rochberger"*) in view of U.S. Patent No. 5,095,458 of Lynch et al. (*hereafter "Lynch"*).

Overview of Rochberger

As Appellants have understood the reference, Rochberger discusses a search tree that allows the use of variable-length keys. The search tree is intended to search addresses of various nodes, where the addresses may be of different lengths. The traditional key used prior to the time of the reference was a prefix of the address. The reference modified the traditional key to include a byte to indicate the length of the address, such that the key used for the method of the reference is "[t]he combined address length byte followed by the address prefix." See col. 8, lines 31 to 48.

The length byte referred to in the reference indicates the actual length of the address. The address itself is a number with a certain number of bits, and is not a string of symbols. The bits are binary values, and not symbols. The reference fails to suggest, or even support an inference that something in the number (i.e., the address) could be referred to as a symbol. The length byte thus refers to the length of the address (i.e., the number of bits), and not to an individual symbol in the address. See col. 11, line 58 to col. 12, line 43.

The reference also discusses the use of a "count" value, which refers to a number of addresses that have the same length. The count value thus also does not refer to any specific symbol in a string of bits. See col. 11, line 58 to col. 12, line 43.

Overview of Lynch

As Appellants have understood the reference, Lynch discusses a "tree structure" for performing carry lookahead. See col. 3, lines 34 to 46; also, Summary at col. 4, lines 12 to 30. The "tree structure" of Lynch is for performing arithmetic operations (e.g., adds, NANDs), and is not indicated as having anything to do with a search tree. The bits are not "stored" at the various levels of logic in the reference for later retrieval, but are rather transitorily generated for use as inputs to the next level to implement the arithmetic function. The various levels of the arithmetic logic can be referred to as levels of logic, or "logic levels," meaning hardware for performing logic operations in the adder, e.g., a NAND function. See, e.g., col. 8, lines 10 to 18; col. 4, lines 12 to 30; Figures 5 and 6.

Discussion of Failure of Motivation to Combine the References

As indicated above, Rochberger discusses a search tree, and Lynch discusses a logic tree for performing logic functions. Appellants note that to establish a prima facie case of obviousness under MPEP § 2143:

> three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings.

As explained in MPEP § 2142, to establish a prima facie case of obviousness, the following apply:

> **TO RELY ON A REFERENCE UNDER 35 U.S.C. 103, IT MUST BE ANALOGOUS PRIOR ART**
>
> The examiner must determine what is "analogous prior art" for the purpose of analyzing the obviousness of the subject matter at issue. "In order to rely on a reference as a basis for rejection of an applicant's invention, **the reference must either be in the field of applicant's endeavor or, if not, then be reasonably pertinent to the particular problem** with which the inventor was concerned." *In re Oetiker*, 977 F.2d 1443, 1446, 24 USPQ2d 1443, 1445 (Fed. Cir. 1992).
>
> . . .
>
> Obviousness can only be established by combining or modifying the teachings of the prior art to produce the claimed invention **where there is some teaching, suggestion, or motivation to do so found either explicitly or implicitly in the references themselves or in the knowledge generally available to one of ordinary skill in the art**. "The test for an implicit showing is what the combined teachings, knowledge of one of ordinary skill in the art, and the nature of the problem to be solved as a whole would have suggested to those of ordinary skill in the art." *In re Kotzab,* 217 F.3d 1365, 1370, 55 USPQ2d 1313, 1317 (Fed. Cir. 2000).

Emphasis added. Appellants note that as explained in Lynch at col. 3, lines 20 to 33, Lynch discusses the use of a binary tree. Additionally, the search tree of Rochberger appears to be based on the concept of binary trees. Even assuming that both references discuss the use of binary trees, Appellants submit that the similarities between the two references end at the similarities in layout, or the use of the tree structure. Appellants submit that there is no motivation to combine two references where one reference discusses arithmetic logic for a lookahead carry tree and the other reference discusses a search tree, as is the case with Lynch and Rochberger, respectively. The cited motivation to combine in the Final Office Action at page 5 is "because providing the logical level allows the prevention of trees becoming large and inefficient as taught by" Lynch at col. 3, lines 34 to 45. Appellants respectfully traverse. The cited section of Lynch recites in full:

> The Binary Lookahead Carry tree, FIG. 5 has gate delays related to the log base 2 of the add length, plus overhead. As in the case with the carry lookahead adder, circuit loading prevents the realization of the log base 2 gate delays for large trees, i.e., trees for adds bigger than about 8 bits. Also, as is known to anyone skilled in the art, the tree becomes large and inefficient to layout for large adds. The MODL gate adder, described in the 1988 IEEE Solid-State Circuits Conference Digest of Technical Papers, is an attempt to alleviate some of these problems and allows for a log base 2Xlinear performance (less than log base 2) for larger adds.

Appellants are unable to understand how the above-cited portion of Lynch is purported to teach providing logic levels to allow the prevention of trees becoming large and inefficient, as asserted by the Final Office Action. As Appellants have understood, the cited portion of the reference refers to the delay resultant from using the binary lookahead carry tree, as understood in the context of col. 3, lines 20 to 33. No "logical levels" are provided by Lynch. The levels of logic refer to the circuitry present at each level of the tree, and are provided to perform bit manipulation to perform a carry in an add operation. The reference fails to mention or suggest providing anything to prevent the trees from becoming large, but merely notes the problems inherent in having large trees. Thus, Appellants submit that for at least these reasons the reference fails to support the assertions in the Final Office Action.

Furthermore, MPEP § 2143.01 states:

> **THE PROPOSED MODIFICATION CANNOT RENDER THE PRIOR ART UNSATISFACTORY FOR ITS INTENDED PURPOSE**
>
> If proposed modification would **render the prior art invention being modified unsatisfactory for its intended purpose**, then there is no suggestion or motivation to make the proposed modification. *In re Gordon*, 733 F.2d 900, 221 USPQ 1125 (Fed. Cir. 1984) (Claimed device was a blood filter assembly for use during medical procedures wherein both the inlet and outlet for the blood were

> located at the bottom end of the filter assembly, and wherein a gas vent was present at the top of the filter assembly. The prior art reference taught a liquid strainer for removing dirt and water from gasoline and other light oils wherein the inlet and outlet were at the top of the device, and wherein a pet-cock (stopcock) was located at the bottom of the device for periodically removing the collected dirt and water. The reference further taught that the separation is assisted by gravity. The Board concluded the claims were *prima facie* obvious, reasoning that it would have been obvious to turn the reference device upside down. The court reversed, finding that if the prior art device was turned upside down it would be inoperable for its intended purpose because the gasoline to be filtered would be trapped at the top, the water and heavier oils sought to be separated would flow out of the outlet instead of the purified gasoline, and the screen would become clogged.).
>
> . . .
>
> **THE PROPOSED MODIFICATION CANNOT CHANGE THE PRINCIPLE OF OPERATION OF A REFERENCE**
>
> If the proposed modification or combination of the prior art would **change the principle of operation of the prior art invention being modified**, then the teachings of the references are not sufficient to render the claims *prima facie* obvious. *In re Ratti*, 270 F.2d 810, 123 USPQ 349 (CCPA 1959) (Claims were directed to an oil seal comprising a bore engaging portion with outwardly biased resilient spring fingers inserted in a resilient sealing member. The primary reference relied upon in a rejection based on a combination of references disclosed an oil seal wherein the bore engaging portion was reinforced by a cylindrical sheet metal casing. Patentee taught the device required rigidity for operation, whereas the claimed invention required resiliency. The court reversed the rejection holding the "suggested combination of references would require a substantial reconstruction and redesign of the elements shown in [the primary reference] as well as a change in the basic principle under which the [primary reference] construction was designed to operate." 270 F.2d at 813, 123 USPQ at 352.).

Emphasis added. Appellants submit that in order to combine the cited references, where one reference discusses the use of logic to provide carry operations and the other reference discusses a search tree, the cited references would have to be changed from their principle of operation and would render the cited reference unfit for their intended purpose. As mentioned above, Lynch discusses logic, and fails to support an interpretation that its tree could store values at its node for later retrieval. Furthermore, Rochberger fails to provide logic for performing carries.

For at least the above-mentioned reasons, Appellants submit that there is no motivation to combine the references. Thus, the Final Office Action fails to set forth a prima facie case of obviousness under MPEP § 2143. Therefore, Appellants respectfully submit that the rejection of the claims on the grounds of obviousness is improper, and petition the Board to overrule this rejection.

Discussion of the Deficiencies of Rochberger

A discussion of the teachings of this reference is set forth above. In brief review, Appellants note that Rochberger fails to disclose or suggest assigning a logical level number to a symbol in a key that is a string of symbols, as recited in the claimed invention. In contrast, Rochberger discusses attaching to each key a number representing the length of the address, and a number indicating how many keys have identical length. The given numbers in Rochberger refer only to an address as a whole, (specifically to the number of bits in the address), and not to individual symbols of a string of symbols. Even assuming that Rochberger could be interpreted as referring to symbols in a string, which Appellants do not concede, the Final Office Action at page 5 admits that the reference fails to teach assigning a logical level.

At least because Rochberger fails to disclose or suggest logical levels, Appellants submit that the reference cannot possibly disclose storing an entry based at least in part on the logical level number, as recited in the claimed invention. Somehow the Final Office Action at page 5 asserts that the reference discloses the mentioned element of the claims. Appellants do not understand how the Final Office Action can both admit that the reference fails to disclose the feature of a "logical level number," and yet still assert that the reference discloses storing an entry based on the logical level number. Regardless of the self-contradiction assertions within the Final Office Action, Appellants submit that the reference fails to support the rejection. The reference discusses storing the keys in nodes based on the length byte. See col. 12, lines 26 to 43. To reiterate what is stated above, the length byte refers to a value referring to a number of bits in the address value as a whole. Thus, Rochberger discusses storing keys based on a value that refers to a number of bits in the address, which is in contrast to storing an entry for the key based on a logical level number of a symbol in a key that is a string of symbols, as recited in the claims.

As to invention as recited in claim 5, Appellants note that claim 5 recites creating a pointer from the node in the first-level of nodes corresponding to a first symbol in a key to a node in a second level of nodes corresponding to the **last symbol** in the key. Nothing in the cited reference suggests that a pointer from one node in *Rochberger*'s tree would point to anything other than the next (or in the case of the "previous" pointers, the previous) -level node in the tree. Appellants submit that the search methods of *Rochberger* assume that this is the case, and begin at the node of longest key length, and step down one node-level at a time until the matching key is found. Therefore, Appellants submit that the cited reference fails to disclose or suggest at least this element of the claimed invention. Thus, the Final Office Action fails to set forth a prima facie case of obviousness under MPEP § 2143. Therefore, Appellants respectfully submit that the rejection of the claims on the grounds of obviousness is improper, and petition the Board to overrule this rejection.

Discussion of the Deficiencies of Lynch

The Final Office Action merely cites Lynch as disclosing a "logical level," which Appellants have shown above to be unsupported by the reference. Appellants further submit that Lynch fails to disclose at least the same elements of the claimed invention as set forth above. Thus, Lynch fails to cure the deficiencies of Rochberger. Because the references, whether alone or in combination, fail to disclose or suggest at least one element of the invention as recited in the claims, the Final Office Action fails to set forth a prima facie case of obviousness under MPEP § 2143. Therefore, Appellants respectfully submit that the rejection of the claims on the grounds of obviousness is improper, and petition the Board to overrule this rejection.

Regarding the Dependent Claims

Appellants have shown above that the Final Office Action fails to set forth a prima facie case of obviousness under MPEP § 2143. Appellants respectfully submit that the invention as recited in the independent claims is therefore nonobvious and patentable over the cited references. As per MPEP § 2143.03, when independent claims are nonobvious over the cited references, dependent claims are likewise nonobvious over the cited references for at least the same reasons as the independent claims. Therefore, Appellants respectfully submit that the Final Office Action fails to establish a prima facie case of obviousness, making a rejection of the claims on the grounds of obviousness improper. Appellants thus petition the Board to overrule the rejection of these claims.

CONCLUSION

Appellants respectfully submit that all appealed claims in this application are patentable and request that the Board of Patent Appeals and Interferences overrule the Examiner and direct allowance of the rejected claims.

A single copy of this brief is submitted as per 37 C.F.R. §41.37(a), along with a check for $320.00 to cover the appeal fee for one other than a small entity as specified in 37 C.F.R. §1.17(c). Please charge any shortages and credit any overcharges to our Deposit Account No. 02-2666.

Respectfully submitted,
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Date: October 3, 2005

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I hereby certify that this correspondence is being deposited with the United States Postal service as first class mail on the below date with sufficient postage in an envelope addressed to: Commissioner for Patents, P.O. Box 1450 Alexandria, VA 22313-1450

Signature: ______________________ 10/03/05
Theresa Belland Date

APPENDIX A: CLAIMS ON APPEAL

1. (Original) A method comprising:

assigning a logical level number to a symbol in a key comprising a string of symbols; and

storing an entry for the key in a level of nodes of a multiway radix tree based at least in part on the logical level number instead of on a path between nodes representing every symbol in the key.

2. (Original) The method of claim 1, wherein the data structure is comprised of levels of nodes arranged according to ascending magnitude of logical level numbers assigned to the levels of nodes.

3. (Original) The method of claim 2, wherein a minimum number of symbols of the key are used to differentiate the key from other keys stored on the tree, and the data structure has only levels of nodes for the symbols of the key that are used to differentiate the key from other keys stored on the tree.

4. (Original) The method of claim 2, wherein a search for the key uses the logical level number corresponding to a length of the key to find the level of nodes storing the key.

5. (Original) A method comprising:

creating a root node and first-level nodes of a tree for storing keys in a memory, each key having a string of symbols;

creating a pointer from the root node to a node in the first-level of nodes corresponding to the first symbol in a key;

creating a second level of nodes to store an entry for the key in a node corresponding to the last symbol in the key; and creating a pointer from the node in the first-level of nodes corresponding to the first symbol in the key to the node in the second level of nodes corresponding to the last symbol in the key.

6. (Original) The method of claim 5, further comprising assigning a first logical level value of one, corresponding to the first symbol in the key, to the logical level number for the first level of nodes; and

assigning a second logical level value of n to the logical level number for the second level of nodes corresponding to the last symbol in the key, wherein n equals the number of symbols in the key.

7. (Original) The method of claim 6, wherein a new level of nodes to store an entry for a new key in a node corresponding to the last symbol in the new key is added to and/or inserted between the existing levels of nodes in the tree based on ordering all the levels of nodes in the tree in sequence according to ascending logical level numbers.

8. (Original) The method of claim 7, further comprising rearranging pointers that exist between a parent level of nodes and a child level of nodes when a level of nodes having a logical level number between the logical level numbers of the parent level of nodes and the child level of nodes is inserted between the parent level of nodes and the child level of nodes.

9. (Original) The method of claim 8, wherein the rearranging includes maintaining a logical path between nodes representing symbols in a key as the number of logical levels between nodes representing a first symbol in the key and a last symbol in the key changes.

10. (Withdrawn) A method, comprising:

a) ascertaining a logical level number that corresponds to the length of a key comprising a string of n symbols in a table of stored key entries organized as a tree of nodes;

b) searching a root node in the tree for a pointer to a node corresponding to a first symbol in the key;

c) searching the node corresponding to the first symbol in the key for a pointer to a next level of nodes;

d) ascertaining whether the next level of nodes is assigned the logical level number that corresponds to the length of the key;

e) searching for an entry for the key on the next level of nodes if the next level of nodes is assigned the logical level number;

f) searching for a pointer on the next level of nodes to a subsequent next level of nodes if the next level of nodes is not assigned the logical level number that corresponds to the length of the key; and

g) repeating d-f until one of the key entry is found, there are no more pointers to subsequent levels of nodes, and a number of levels of nodes corresponding to a number of all the symbols in the key have been searched.

11. (Withdrawn) The method of claim 10, further comprising inserting a new level of nodes to store the key if the key is not found, comprising:

following a first pointer from the root node to the node corresponding to the first symbol in the key;

searching the node corresponding to the first symbol in the key for a second pointer to a next level of nodes;

if the second pointer does not exist, then creating a next level of nodes, storing an entry for the key in a node corresponding to the last symbol of the key, and assigning logical level number corresponding to a length of the key to the level of nodes in which the key is stored;

if the second pointer exists and points to a level of nodes having a logical level number corresponding to the length of the key, then storing an entry for the key in a node corresponding to the last symbol of the key; and

if the second pointer exists and points to a level of nodes not having a logical level number corresponding to a length of the key, then inserting a new level of nodes to store an entry for the key, and inserting the new level according to ascending magnitude of the logical level numbers of all the levels of nodes in the tree, starting at the root node.

12. (Original) An apparatus, comprising:

a register to store an entry for a key having a string of symbols in a tree data structure representing a table; and

a node generator to add a node to the tree to store the key entry based on the last symbol of the key, wherein the node is assigned a logical level number corresponding to the length of the key; and

wherein the logical level number of the node storing the key is used to find the key instead of a path between nodes corresponding to each symbol in the key.

13. (Original) The apparatus of claim 12, further comprising:

a receiver to receive keys; and

an inserter to insert an entry for each key to be stored into the node created by the node generator.

14. (Original) The apparatus of claim 12, further comprising:

a finder to:

follow a pointer to a node corresponding to the first symbol of the key being searched for;

search the node corresponding to the first symbol of the key for a pointer to a level of nodes having the logical level number as the key being searched for; and

search for an entry for the key on the level of nodes having the logical level number of the key being searched for.

15. (Withdrawn) An article of manufacture, comprising:

a machine-readable medium comprising instructions, that when executed cause a machine to:

generate a tree for storing keys in a memory, the tree having a root node, each key having a string of symbols;

receive a key having an entry to be stored in a node of the tree; and

store an entry for the key in a node corresponding to the last symbol in the key in a level of nodes assigned a logical level number corresponding to the length of the key.

16. (Withdrawn) The article of manufacture of claim 15, further comprising instructions, that when executed, cause a machine to:

a) search for an entry for a key comprising a string of n symbols in a table of stored key entries organized as a tree of nodes by ascertaining a logical level number that corresponds to the length of the key;

b) search a root node in the tree for a pointer to a node corresponding to a first symbol in the key;

c) search the node corresponding to the first symbol in the key for a pointer to a next level of nodes;

d) ascertain whether the next level of nodes is assigned the logical level number that corresponds to the length of the key;

e) search for an entry for the key on the next level of nodes if the next level of nodes is assigned the logical level number;

f) search for a pointer to subsequent next level of nodes if a parent level of nodes is not assigned the logical level number that corresponds to the length of the key; and

g) repeat d-f until one of the key entry is found, there are no more pointers to subsequent levels of nodes, and a number of levels of nodes corresponding to a number of all the symbols in the key have been searched.

17. (Withdrawn) The article of manufacture of claim 15, further comprising instructions, that when executed, cause a machine to:

follow a first pointer from the root node to the node corresponding to the first symbol in the key;

search the node corresponding to the first symbol in the key for a second pointer to a next level of nodes;

if the second pointer does not exist, then create a next level of nodes, storing an entry for the key in a node corresponding to the last symbol of the key, and assigning logical level number corresponding to the last symbol in the key to the level of nodes in which the key is stored;

if the second pointer exists and points to a level of nodes having a logical level number corresponding to a length of the key, then store an entry for the key in a node corresponding to the last symbol of the key; and

if the second pointer exists and points to a level of nodes not having a logical level number corresponding to the length of the key, then insert a new level of nodes to store an entry for the key, inserting the new level in sequence according to ascending logical level numbers of all the levels of nodes in the tree, the ascending starting at the root node.